Firewalking

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Summary. Firewalking is known throughout recorded history and around the world. Ordinarily it is associated with religious beliefs or mystical states of mind in which the gods or unusual mental powers provide extraordinary protection for true believers or those with proper training. However, firewalking commonly involves hot materials of low heat capacity and poor thermal conductivity and sometimes the use of insulation. The excited or trance-like states of firewalkers contribute to the firewalkers' subjective experience but are not required for a successful walk. We conclude that elementary knowledge of physics and psychology is sufficient to explain the known observations of firewalking.
Key words. Firewalking; occult; paranormal events; pain perception; thermodynamics; magic; mysticism.

Introduction

In the Old Testament book of Proverbs (6:28) the question is asked, 'Can a man walk on red-hot coals without burning his feet'? The prophet Isaiah considered this question and he said (42:2), 'Should you walk through fire, you will not be scorched and the flames will not burn you'. To understand why this answer might be true requires a knowledge of the elementary properties of heat and materials and of the nature of human perception. This knowledge is part of our common everyday lore.

The firewalkers we have studied follow an often unwitting policy of misdirection and confusion that increases the perceived mysterious nature of the firewalk and reduces the likelihood of careful analysis and thought. These are the techniques of magicians. Just as a magician waves his hands and hat around, gestures to his glamorous assistant, intones magic words and displays an actual rabbit in his hand, so the firewalkers take ritual baths, sprinkle salt on the wood, chant prayers or a mantra and actually walk on hot coals. In both cases the antecedents are irrelevant to the actual acts of pulling the rabbit from a hidden pouch in the magician's jacket or of walking across a bed of glowing embers. But if a magician were to say, 'Here is a rabbit I've hidden in my jacket', as he displayed the hapless rabbit, no one would be amused or entertained. The magic is in the presentation. Similarly, if the firewalkers were to say, 'Anyone can do this. It just takes some courage and motivation', no one would think themselves powerful, intelligent or favored by the gods for having walked on hot coals.

In this paper we intend to lift the fog of misdirection and confusion and explain what actually happens during a firewalk. We begin by describing some firewalks from around the world. We will explain the nature of heat and apply this to understanding the firewalk. We will discuss why people participate in firewalks and what the real psychological factors are that operate during a firewalk. Finally we will examine some of the commonly accepted explanations for firewalking and consider why many people prefer these to the conventional ones of modern science.

Descriptions of firewalks from around the world

Firewalking is found throughout the world and has existed from ancient times. The Bible frequently criticizes what appears to be firewalking. In Deuteronomy (18:9), for example, it is said, 'There must never be anyone among you who makes his son or daughter pass through fire, who practices divination, who is soothsayer, augur, or sorcerer, who wears charms, consults ghosts or spirits, or calls up the dead'. Malhotra and Khomne[22] refer to a Brahmin firewalk described in the *Tandya Brahmana* which dates from around 800 B.C. In more recent times firewalking has been described by anthropologists, spiritualists and travelers. At the turn of the century firewalking was a matter of interest among those who were interested in psychic phenomena. Lang[17] and Beauchamp[1, 14] provide a collection of firewalking descriptions from many areas of the world by intelligent observers without substantial scientific knowledge. Lang concluded that while there was no reason to believe that nonphysical factors were at work there was also no suitable explanation for the phenomena.

Three *National Geographic* articles[20, 23, 39] contain eyewitness accounts with some photographs of firewalking in Singapore and Fiji. We quote at length from Lewis's[20] description of Hindu firewalking in Singapore:

"The devotees, including quite a number of women, approximated 400. Some were kneeling and touching the earth with their foreheads, while others, more devout, were literally groveling in the dirt. A few were endeavoring to crawl or roll completely around the temple...

"Many of those who had made a vow to undergo torture had prepared their bodies the preceding month by some form of penance and had refrained from eating for a day before the event.

"While these zealots were proceeding with their tasks, a bed of coals was being prepared. Great piles of wood were burned to embers; then the ashes were raked into a neat bed about 24 feet [8 m] long.

At the end of the mass of live coals was dug a pool, which was filled with milk... The images of the gods were then brought from the temple and placed near this pool of milk.

"When all seemed in readiness, we heard the sound of drums and a stir of excitement swept over the crowds. The crowds were now in a frenzied state... The staring eyes of the devotees seemed glued upon the idols at the other end of the path of glowing embers.

"Finally, the priests who held back the devotees began to lash them with whips, and one by one they made a dash, barefooted, across the red-hot coals into the pool of milk...

"The priests would sometimes strike a devotee several times, and then give the wrists a stinging blow before releasing him. Not one flinched, nor did any appear to have felt the cut from the whip. Some ran and some walked slowly through the coals.

"The women seemed much calmer than the men. Some of them carried babies in their arms."

Malhotra and Khomne[22] provide a careful description of firewalking at one town in India. They examined the walkers' feet and could find no evidence of insulating material. The walkers stepped into a pool of coconut milk before passing through the embers. Freeman[13] describes a firewalk ceremony in India that led to several burns and was considered a failure by the townspeople. Although his interest is cultural, he relates the various preparations made by the villages. These include the presentation of expensive gifts to

the god Kali, seclusion, lying down and rolling through the village streets, ritual baths, special prayers, and other religious rites.

Obeyesekere[28] provides a thorough examination of the cultural significance of firewalking at the shrine of Kataragama in Sri Lanka, but does not hazard an explanation as to how it is performed. Feinberg[9], on the other hand, colorfully describes a Sri Lankan firewalk that the witnessed and after examining many explanations concludes that the god himself is most likely responsible.

Feigen[8], an adventuring surgeon and writer, has provided us with an amusing account of a firewalk in Raiatea in the South Pacific. There the firewalkers stride across rocks that have been heated for hours by burning wood. Feigen ventured to walk himself. "I suddenly found myself reaching down to take off my sneakers and socks... From my legs up, I was aware of a frighteningly intense, though bearable, heat; my legs and feet felt cold. I moved along steadily, looking down, unaware of any special pathway... The rock surfaces felt like sandpaper and made my feet tingle. I saw no one. At last I had stopped reasoning! I stepped off as if awakening from sleep... 'Bring me some water', I said, 'and I'll turn it into wine'! It was after the Tahitians thanked me for participating that I realized that I was burned. I had felt very little for ten or fifteen minutes, but now the pain was severe."

Doherty[7] describes Greek firewalkers, who dance on glowing embers while protected by the grace of St. Constantine. In addition to walking on hot embers or rocks there are a number of related heat stunts such as licking red hot knives, which was used as a judicial test in some cultures; carrying burning embers, which is one of many such stunts reportedly done by certain saints; and sticking fingers into boiling oils or molten metals. Many of these stunts have been described and explained by Coe[3], Walker[40], and Curzon[4].

Kane[16] describes a Christian sect of firehandlers, who as part of their worship service pass flames over their bare skin. Although we will not deal with this phenomenon here the careful reader will be able to develop his own explanation.

Physical factors involved in firewalking

To understand firewalking we must separate the physical question of what prevents the walker's feet from burning from the psychological question of what the firewalker will perceive as he or she walks across the coals. This section of the paper deals with the first question. To understand the answer it is necessary to know something about the nature of heat and the properties of materials. The explanation that we offer is not original. The first experimental observation and empirically tested explanation was offered by an American visitor to Sri Lanka[18, 38]. Excellent observations and experiments were carried out in England in the 1930s[2, 5, 29, 31, 32, 33], and in Sri Lanka in the 1960s[12, 34]. These researchers all arrived at the correct explanation.

In brief, firewalking is possible because the materials that are walked on, embers or rocks, have a low heat capacity and a poor thermal conductivity while our feet have a fairly high heat capacity. During the short time of the firewalk not enough heat is transferred to the walker's feet to produce a burn.

For our readers with a non-technical background the meaning of these statements can be appreciated by considering a cake baking in an oven. If the cake has been baking for a sufficient time then everything in the oven has reached a high temperature, say 200 °C. When the baker opens the oven to remove the cake she does not worry about being burned by the 200 °C oven air or by the 200 °C cake surface. However, she would use a pot holder as an insulator to protect her from the 200 °C aluminum cake pan. So we see that different materials at the same temperature have different abilities to burn us. This is due to the fact that having the same temperature and having the same amount of heat energy are not the same thing. At the same temperature aluminum holds much more energy in it than the oven air. Materials also have differing abilities to carry heat from one place to another. The aluminum pan can transfer much larger quantities of heat energy to the baker's hands than the cake is able to transfer. An additional factor is the length of time that the baker's hand is exposed. If she were to leave her hands in the oven for a long enough time they would be baked, but during the short time that is necessary to remove the cake, the air cannot transfer sufficient energy to her hands to raise their temperature very much. The aluminum pan, however, can do so quite quickly. The materials that fire walkers choose to walk on are more like the cake in their thermal properties. Firewalkers do not walk on red hot aluminum frying pans. Another factor that may play a role is insulation. Just as a pot holder will protect the baker's hand so any insulation will help to protect a firewalker's foot. Insulation might include dirt, calluses, or water.

Field studies of fire walking are difficult to carry out. There are many factors that interact during the firewalk and they are rarely under the control of the researcher. Still it is possible to do excellent work as indicated by the studies cited above. The mystical and religious atmosphere, not to mention the hoopla, make it difficult to concentrate on the significant factors. Nevertheless important observations can be made. For example, often the walkers leave dark footprints behind them. This is indicative of the cooling of the embers where they have stepped. Coe[3] suggests that this is due to the blocking of the oxygen supply to the outer burning layer, but it seems just as likely that the darkening of the embers represents their cooling due to the loss of energy to the foot. These footprints fade away in a minute or two as the chemical reactions reheat the embers. It may be possible to see the dark spots in the embers in figure 1.

We cannot resist describing in some detail the firewalks of Ahmed Hussain, an Indian magician and firewalker. In 1937 Hussain allowed himself to be studied in England[2]. Following his instructions the English researchers prepared a 4-m-long ember-filled trench. After appropriate temperature measurements and sole-searching examinations by the scientists and appropriate prayers by Hussain, he successfully walked through the coals. Next he offered to transfer his immunity to volunteers who would follow him through the embers. Remarkably some brave volunteers were present and they dutifully and successfully walked. They were followed by an intrepid Englishman who walked unaccompanied. Hussain was not abashed. Yes, he said, some unprotected walkers could survive such a short walk, but he could walk indefinitely. When the researchers invited him to walk back and forth in the fire pit he demurred saying that he could only walk in a straight line. The scientists obliged him the next weekend by doubling the length of the pit. Hussain said his prayers and strode through the pit. Unfortunately, this time his faith was insufficient and he received painful blisters. The researchers concluded that the transfer of heat was cumulative while Hussain, as is common with those who find themselves in circumstances too hot to handle, blamed his failure on the press.

The Leidenfrost effect or 'spheroidal' state of matter is commonly advanced as an explanation for firewalking[4, 40]. In the context of firewalking, this effect refers to water vapor serving as a barrier to the transmission of heat from the hot coals to the foot. This principle is perhaps best understood in terms of some of its everyday applications. Cooks will sprinkle water onto a skillet to see if it is hot enough. As the skillet is warming, the drops of water will evaporate quickly. If the skillet has reached a high enough temperature, the drops will dance on the hot surface for a surprisingly long time. This is

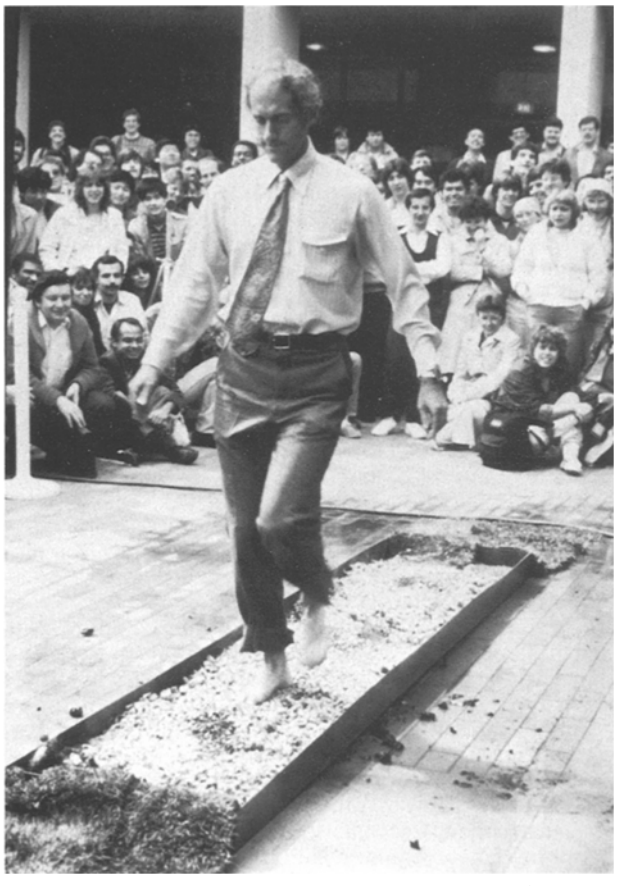

Figure 1. Author Leikind tests his theories during a demonstration for an introductory thermodynamics class at the University of California at Los Angeles. It is possible, in the original color photograph, to see dark spots identifying his previous two steps and those of earlier walker. (Photo by K. Willis, University of California at Los Angeles)

due to a layer of water vapor which forms between the drop and the skillet. Vapor, being a gas, is a relatively poor conductor of heat, and thus 'protects' the drop of water from evaporation by heat. Wetting one's finger before touching an iron to see if is hot as a way of protecting one's finger from getting burned is another example of the application of the Leidenfrost effect. It is often suggested that moisture on the foot, perhaps from sweat alone, provides sufficient vapor to protect it.

While it is true that many firewalkers wet their feet before the walk, some believe that moisture makes it more likely that an ember will stick to their feet causing a burn. These latter firewalkers carefully dry their feet before walking. At the Japanese firewalk described below there was no water present and the hardpacked dirt around the fire was cold and dry. The chilly temperatures made it unlikely that anyone was sweating and what sweat might have appeared was surely absorbed by the dry earth. Brown [2] had one of his subjects walk across the fire wearing a pair of rope-sole sandals and the sandals were not harmed. Dennett [6] did his firewalk with a Band-Aid on the sole of one of his feet. The Band-Aid was also not damaged. Neither the sandals nor the Band-Aid would have been protected by the Leidenfrost effect from sweat. Brown moistened the sandals and held them against the embers. It took several seconds for the sound of steam formation to appear. He concluded that the Leidenfrost effect (or spheroidal state as it was known then) was not a factor in the firewalk that he observed. We agree. Any water present on the feet is helpful insofar as it serves as a heat absorber and insulator, but there is not convincing evidence that the Leidenfrost effect is present or significant.

Although the Leidenfrost effect is not a significant factor in firewalking it is involved in some of the other heat stunts related above. For more detail and for explanations the interested reader should refer to the works cited above.

Anyone can firewalk on a prepared bed of embers. Whether the walkers' feet are wet or dry the danger of embers sticking is primarily from embers that might get caught between the toes. This problem is best dealt with by walking with a smooth even stride without pressing the toes down hard on the embers. It is also wise to wipe off the feet immediately after reaching safety.

Psychological factors involved in firewalking

Why do people walk on hot coals?

Thrill-seekers, researchers, and entertainers aside, most firewalkers consider the firewalk as a source of personal power, spiritual purity, or, perhaps, as a reflection of the favor of the gods. At the firewalk in Singapore, for example, the ritual was supposed to have been started by a goddess who wished to demonstrate her chastity to her husband. At the Sri Lanka firewalks the participants were often repaying a debt of honor to the gods who had cured them or some relative of illness. At the Japanese firewalk described below many walkers felt that the prayers and ritual walk would be of benefit to their ancestors' spirits and to their own health. Although ceremonies in the South Pacific certainly began as religious rites they are now carried out on a regular basis for tourists. In the United States firewalking has become something of a fad in recent years, where it appears as a very effective motivational or persuasive tool at self-help seminars.

Coping with pain

Although we have explained why burns are not as likely as one might expect, and have considered some of the motivations for firewalking, we must still account for the psychological factors involved in the actual walk. Firewalks are commonly preceded by extensive religious or mystical preparation. Walkers commonly report feeling an altered state of consciousness and an insensitivity to the feeling of heat in their feet. These factors do not determine whether a firewalker will be burned but they do have an important effect upon the walkers' subjective impressions of the walk. Since the publication of the 'gate control' theory of pain [25], it has become widely recognized that the perception of pain is psychologically mediated. Individuals suffering from the same degree of physical injury can nevertheless vary considerably in their perception of pain. Cultural background, gender, the context in which the injury was sustained and individual differences in pain tolerance all influence reports of pain [37]. A variety of behavioral techniques are now commonly in use for the psychological analgesia of chronic pain. Acupuncture, biofeedback, meditation, progressive muscle relaxation, visual imagery and physical activity have been used to moderate pain. Simply distracting individuals suffering from pain can help to diminish the intensity of the pain they report experiencing, by reducing the individuals' cognitive capacity for attending to all pain-relevant information [30]. Psychologists and those who have used the Lamaze method of child birth know that distraction techniques such as visual imagery, physical activity, energetic breathing and chanting a mantra can effectively reduce pain [24].

Some case studies

We began our investigation of firewalking by attending a self-help seminar in Southern California. Our plan was for

only one of us (McCarthy) to take the seminar training. Then we would both (McCarthy and Leikind) attempt the firewalk[19].

What motives would induce an otherwise ordinary American to attempt to walk on fire? We noted that the brochures used to advertise the firewalk seminar promised that the seminar and firewalk would increase participants' self-esteem, decrease their anxiety and make it possible for them to realize their deepest hopes. We suspect that most of the participants we met at the firewalk seminar were hoping to improve their self-respect in a brief period with minimal effort. It is commonly the case that individuals who are attracted to self-improvement programs tend to be suffering from a personal crisis or experiencing an acute life change such as a divorce or job transfer[27]. The people who attended the firewalk seminar could have come, as we did, because of curiosity. And some probably came because of encouragement by a friend who had completed a firewalk before.

For the many who chose to participate in the firewalk as a means of improving their self concept and who paid the $ 125 fee, there was a vested interest in believing the seminar leaders' explanation that walking on hot coals unscathed was a reflection of the strength of the firewalker's mind.

The seminar might not have prevented burns but did include elements that seemed likely to help the attendees to walk on hot coals without perceiving pain. The seminar spanned a whole evening, ending after midnight. The leader led 80 participants through a series of psychological exercises designed to stimulate the disclosure of personal fears, the development of camaraderie and positive thinking. As with most pop psychology seminars, the program called upon the participants to shed their fears, to enlarge their expectations for themselves and to take action in pursuit of self-relevant goals. The program was accompanied by deafeningly loud music, dancing and orchestrated participant-to-participant back rubs. After several hours of emotionally uplifting activities and inspirational self-improvement homilies, most participants appeared to be happy, relaxed and optimistic about meeting the challenge of walking on hot coals.

The content of the seminar was primarily exhortational, positive-thinking nostrums. Relatively little time was devoted to actually preparing the participants for the firewalk. Only at the end of the seminar were explicit instructions given. One was advised, for example, to 1) believe strongly in one's likelihood of success; 2) breathe deliberately and noisily; 3) focus one's eyes on a spot in the sky, not on the coals; 4) walk confidently at a normal walking pace; 5) override any possibly negative thoughts by chanting a mantra (suggested mantra: 'cool moss'); and 6) wipe one's feet on the wet grass at the conclusion of one's walk on the bed of hot coals. With the exception of the last, these instructions are reminiscent of Lamaze training.

At the end of the seminar both authors firewalked successfully. The one who attended the seminar received only a small blister. The one who did not receive the training and did not obey any of the instructions except the last was unscathed after two walks.

We subsequently conducted an audience-participation lecture-demonstration at the California Institute of Technology before a large audience[19]. After our lecture we invited members of the audience to walk on a bed of hot coals that we had prepared for them. Some seventy or eighty people followed us across the coals and were not burned. We believe that this lends credence to the view that no special training or psychological state is required to successfully firewalk.

One of the authors (Leikind) participated in a firewalk ceremony at the Akibasan Entsuji Buddhist temple in Nagoya, Japan. About one hundred believers, dressed in white jackets and headbands, were prepared to walk through what appeared, at first glance, to be a very hot firewalk and one that was, at 10 meters, about three times the length of the typical firewalk in the United States. The typical participant was a devout, older member of the temple but some young children also participated. Preparation for the actual firewalk included an hour of chanting sutras to the accompaniment of eerie music and the sprinkling of sanctifying salt on the wood.

Figure 2. A Japanese firewalker at the Akibasan Entsuji Buddhist Temple in Nagoya, Japan. Although this firewalker is not wasting any time, many participants walked across the glowing embers. Note the burning firewood at the side of the fire. (Photo by B. J. Leikind)

In constructing their fire, the Japanese had cleverly built up the sides of the fire with a pile of wood almost one meter high while the center consisted of a bed of straw covered by a single layer of wood sticks. After the initial impressively fiery conflagration of the straw, all that remained was a thin layer of glowing but rapidly cooling embers in the large central region of the firewalk. The perimeter, consisting of piles of wood, continued throughout to present to the spectators an impressive display of spires of visible flames in front of and behind the firewalkers. The low heat capacity and poor thermal conductivity of the embers enabled all participants, including one of the authors, to do the firewalk without harm. To the many spectators, however, the firewalk appeared to expose the firewalkers to considerably more heat than was actually the case. Once again, close examination of a firewalk showed that appearances and expectations obscured a phenomenon that was entirely explainable in terms of long-accepted principles of thermodynamics. The photograph in figure 2 shows one of the Japanese walkers.

Personal experience and scientific explanation

Alternate explanations

The curious observer of firewalks will find that a bewildering array of explanations exist. These include the heat capacity and thermal conductivity theory that we have advocated, the Leidenfrost effect that we have disparaged, secret insulation, toughened skin, trained insensitivity, hypnotic or trancelike states, the secretion of endorphins, as well as various mystical, religious, or other exotic effects. Many explanations directly or indirectly state that successful completion of a firewalk without injury requires that one's mind be in a particular state. Older cross-cultural variants of this explanation required extensive preparation to strengthen the mind through prayer, fasting and celibacy. More recent, contemporary, pseudoscientific variants invoke neurolinguistics, psychobiology and neurophysiology to argue for the role that strong beliefs can play in influencing tissue not to burn when exposed to high heat. To date, however, direct rigorous experimental corroboration has not been obtained for any

explanation that required that the mind be in a 'proper state' in order for one's tissues to be protected.

To scientists familiar with basic principles of thermodynamics and psychology, explanations that involve novel, untested and surprising mechanisms for protecting one's tissues from burning are less parsimonious and more confusing than the scientifically more conventional explanation that the poor heat capacity and poor heat conductivity of wood embers simply don't expose the soles of firewalkers to as much heat as is commonly supposed. To the observers who are ignorant of the principles of thermodynamics in particular and ignorant of scientific methods for adducing evidence in general, the competing explanations offered by respected spokespersons may appear equally plausible. How are they to judge which explanation is likely to provide the best description of the phenomenon? Leonard Feinberg's article [9] will serve to illustrate this problem. He had located many of the articles cited here. He accurately summarized all the major explanations, physical, as well as psychological. He then concluded that we should most likely choose the mystical belief that a deity intervenes to protect the firewalkers. The author's implication was that because the scientists were unable to agree on one explanation none of their explanations were believable.

In addition, unsophisticated observers have a tendency to attribute the responsibility for people's successes and failures to their personality rather than to their circumstances [35]. Naive observers will more readily believe an explanation that attributes success at firewalking to a characteristic of the firewalker, such as his or her 'strong' mind, than they will believe an explanation that attributes success at firewalking to the nature of the source of heat.

Why are unconventional explanations preferred to scientific ones?

All humans, whether scientists, religionists, skeptics or mystics, have a limited cognitive capacity for assimilating new information. They use cognitive heuristics, such as stereotyping, to help them manage the immense amount of information that people are commonly exposed to. Virtually all the cognitive heuristics that have been examined have the quality that they lead to reasonable inferences most of the time but lead to clearly erroneous inferences some of the time, often under specifiable conditions.

Many of the cognitive heuristics that humans use are designed to ease the work of long-term memory. While these heuristics generally facilitate accurate perception and memory of experienced events, they do make it possible for people to 'see' or 'remember' events that never occurred.

One heuristic involves remembering events primarily in terms of 'scripts,' generic storyboard descriptions of the event that could apply to any instance of the event. The only actual details remembered from a particular event would be those peculiarities of the event that don't normally appear in the generic script [36]. For example, were a waiter in a fancy restaurant to spill some wine on your jacket, your later account of the event would recount what normally happens in a restaurant script until that point when the waiter spilled the wine. The account of the event, in other words, would not be so much remembered as reconstructed from the generic restaurant script with the spilling of the wine being the only fact actually 'remembered' from that experience.

Unfortunately for trial lawyers, skeptics and others interested in eidetic recall, heuristics designed to aid long-term memory can be manipulated such that people report 'remembering' events that never occurred. Research on people's ability to recall all details associated with a filmed car accident has shown that asking individuals if they saw two cars 'hit' each other leads to significantly fewer reports of broken glass than asking individuals if they saw two cars 'smash' each other. Because so much of memory is reconstructive, the semantics of asking informational questions about one's recall can influence what is 'remembered' [21].

Semantics influences perception as well as recall. Psycholinguists have noted that words influence what colors are seen [26] and influence consequential behavior. A good example is the fire hazard that 'empty' gasoline tanks present. When gasoline tanks are full, their content is liquid and cannot combust readily for lack of oxygen. When gasoline tanks are newly 'empty,' they are filled with gasoline fumes, which are highly combustible. Many a tragedy has occurred because some smoker assumed that 'empty' meant 'safe' [41].

In any case, the limited information processing capabilities of humans require that they use 'schemas' to predict what it is that they are about to witness. The better part of typical language comprehension is anticipating what the speaker is about to say [11]. Unfortunately, the schemas we use may induce us to 'see' only what we expect to see and to miss seeing what actually occurred. Magicians make use of this phenomenon frequently, creating expectations in viewers that distract them from what is actually occurring. At firewalks the entire atmosphere, the expectations concerning the conditions for success, the excitement, the fear of consequences, the heat, the religious or mystical associations and other factors all conspire to place inappropriate explanatory schemata into the minds of the firewalkers and observers.

In particular, the use of the term 'fire' helps to bias the naive observer into thinking that the phenomenon in question is beyond the purview of science, as everyone knows that one cannot walk on 'fire' without getting burned. The truth of the matter, of course, is that 'firewalking' actually involves walking on hot coals, not on 'fire.' Given peoples' preconception that exposure of tissue to 'fire' without injury is impossible, they will not be in a proper frame of mind to ask sensible questions or to accept a scientific explanation. On the other hand, people may not have such strong preconceptions about walking on 'embers' and, therefore, they may be more willing to consider conventional explanations about walking on hot embers.

In addition, people, including trained scientists, tend to hold their existing beliefs rather tenaciously, even in the face of what seems to scientific observers to be considerable contrary evidence. It is a truism in the psychological literature on beliefs that getting people to believe something entirely new or getting them to incorporate a fact into an existing belief is much easier than getting them to change their current beliefs in view of new facts [27]. In the case of beliefs about firewalking, it appears to be more difficult to get individuals to change their beliefs about the normal impossibility of 'walking on fire' without getting burned than it is to get them to believe something wholly new about their mind's ability to prevent their tissue from burning.

Conclusions

In this paper we have learned about the scientifically most acceptable explanation for how people can walk on hot coals without getting burned and we have discussed the actual psychological processes that are at work during a firewalk. The explanation is simple and readily understandable by members of modern society. We have also described the factors that affect the public's acceptance of scientific explanations.

Investigations of the paranormal are a tool for public education. Many paranormal effects are matters of great public interest. Furthermore most of them can be analyzed and understood with ordinary thinking and knowledge without the necessity of advanced training. Also it is fun to figure them out and intelligent nonscientific observers have an op-

portunity to contribute to scientific knowledge. It was an accountant [6] who had the fine idea to put a Band-Aid on the sole of this foot before a firewalk. Let us use the investigation of paranormal phenomena as a tool to educate the public in the nature of scientific thought. We will do this by encouraging them to join us in the endeavor, supporting them in their enthusiasms, and offering them our experience and knowledge.

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Psi experiments: Do the best parapsychological experiments justify the claims for psi?

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Summary. Since the founding of the Society of Psychical Research in 1982, psychical researchers have, in each generation, generated research reports which they believed justified the existence of paranormal phenomena. Throughout this period the scientific establishment has either rejected or ignored such claims. The parapsychologists, with some justification, complained that their claims were being rejected without the benefit of a fair hearing. This paper asks the question of how well the best contemporary evidence for psi – the term used to designate ESP and psychokinetic phenomena – stands up to fair and unbiased appraisal. The results of the scrutiny of the three most widely heralded programs of research – the remote viewing experiments, the psi ganzfeld research, and the work with random number generators – indicates that parapsychological research falls short of the professed standards of the field. In particular, the available reports indicate that randomization is often inadequate, multiple statistical testing without adjustment for significance levels is prevalent, possibilities for sensory leakage are not uniformly prevented, errors in use of statistical tests are much too common, and documentation is typically inadequate. Although the responsible critic cannot argue that these observed departures from optimal experimental procedures have been the sole cause of the reported findings, it is reasonable to demand that the parapsychologists produce consistently significant findings from experiments that are methodologically adequate before their claims are taken seriously.
Key words. Parapsychology; remote viewing; ganzfeld; RNG; PK.